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## (54) Process and apparatus for separating a gaseous mixture

Verfahren und Vorrichtung zur Trennung einer Gasmischung

Procédé et dispositif de séparation d'un mélange gazeux

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(73) Proprietor: **AIR PRODUCTS AND CHEMICALS, INC.**
**Allentown, PA 18195-1501 (US)**

(72) Inventors:
- **McNeil, Brian Alfred**
  **Hook, Chessington Surrey KT9 1PW (GB)**
- **Truscott, Alan Geoffrey**
  **Headley Down, Hants GU35 8EN (GB)**

(74) Representative: **Burford, Anthony Frederick**
**W.H. Beck, Greener & Co.**
**7 Stone Buildings**
**Lincoln's Inn**
**London WC2A 3SZ (GB)**

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## Description

**[0001]** This invention relates to a process and apparatus for separation of hydrogen and carbon monoxide from gaseous mixtures thereof and has particular, but not exclusive, application to mixtures consisting essentially of hydrogen ($H_2$), methane ($CH_4$) and carbon monoxide (CO).

**[0002]** A conventional process for separating hydrogen and carbon monoxide comprises a low temperature scrubbing step using liquid methane to dissolve carbon monoxide, a hydrogen stripping column or flash separator to separate hydrogen from the CO-loaded methane (containing 3% - 4% $H_2$), and a carbon monoxide/methane separation column to separate the hydrogen-stripped CO-loaded methane into carbon monoxide and methane fractions. The hydrogen stripping column normally operates at an intermediate pressure to the methane wash and carbon monoxide/methane separation columns.

**[0003]** GB-A-1,579,553 discloses a said conventional process in which the CO-loaded methane is countercurrently contacted with hydrogen-rich vapour generated by warming the hydrogen-stripped CO-loaded methane internally or externally of the hydrogen stripping column.

**[0004]** US-A-5,295,356 discloses a said conventional process in which the columns are heated and/or cooled by a closed refrigerating cycle, preferably a nitrogen cycle.

**[0005]** US-A-5,592,831 discloses a said conventional process in which the methane wash is conducted with methane containing at least 2 to 15 mol% carbon monoxide. In the exemplified embodiment, the methane scrubbing column and hydrogen stripper are combined into a single column and the hydrogen-stripped CO-loaded methane is fed to the carbon monoxide/methane separation column partly as a subcooled liquid and the remainder after vaporization.

**[0006]** A major problem with the conventional process is that a significant amount of carbon monoxide is lost in the overhead ("reject hydrogen") stream from the hydrogen stripping column or flash separator. This problem has been solved in the past by recycling the reject hydrogen stream to recover the carbon monoxide (and hydrogen), or by washing the reject hydrogen stream with essentially pure liquid methane recycled from the sump of the carbon monoxide/methane separation column to dissolve and recover most of the carbon monoxide (as described in US-A-4,888,035).

**[0007]** It is an object of the present invention to reduce losses of carbon monoxide with the reject hydrogen stream with lower power consumption than said prior art methods.

**[0008]** The Inventors have now found that impure methane withdrawn from an intermediate location above the bottom stage of the methane wash column can be used to provide reflux to the top of the hydrogen stripping column and thereby reduce losses of carbon monoxide in the reject hydrogen stream. Compared to the process of US-A-4,888,035 (which uses essentially pure regenerated methane from the bottom of the carbon monoxide/methane separation column as reflux), the present invention results in a reduction in the total amount of methane reflux required for the columns, and a consequent reduction in heat pump power. In particular, whereas in US-A-4,888,035 the reflux methane is fairly pure (since it is withdrawn from the bottom of the carbon monoxide/methane separation column), the present invention uses a methane-rich stream that has already been used to provide part of the scrubbing duty in the methane-wash column, and usually contains up to 10% CO, but it can be up to 15% CO. For the same CO content in the reject hydrogen stream, this increases the amount of reflux needed for each of the methane wash and hydrogen-stripping columns but the total amount of reflux is reduced since it is employed in series. Consequently the recycle heat pump (typically carbon monoxide) flowrate required for the carbon monoxide/methane column separation is reduced, resulting in a product/recycle carbon monoxide compressor power reduction typically of 2% to 4%.

**[0009]** Accordingly in a first aspect of the invention, there is provided a process for separating hydrogen and carbon monoxide from a gaseous mixture thereof, said process comprising:

(a) scrubbing the gaseous mixture or a gaseous fraction thereof with a liquid methane wash stream in a methane wash column to provide a gaseous hydrogen product stream and a liquid CO-loaded methane stream;

(b) separating said CO-loaded methane stream into a gaseous hydrogen-rich stream and a liquid CO/methane stream in a hydrogen stripping column refluxed with a methane-rich liquid;

(c) separating said CO/methane stream into a gaseous carbon monoxide stream and a liquid methane stream; and

(d) recycling at least part of the liquid methane stream separated from the carbon monoxide stream in step (c) to provide the wash liquid for step (a);

wherein said methane-rich liquid stream is withdrawn from an intermediate location of the methane wash column above the level of removal of said liquid CO-loaded stream therefrom.

**[0010]** In a second aspect of the invention there is provided an apparatus for separating hydrogen and carbon mon-

oxide from a gaseous mixture thereof by a process of the first aspect, said apparatus comprising:

(a) a methane wash column;

(b) a hydrogen stripping column;

(c) a carbon monoxide/methane separation column;

(d) conduit means for feeding liquid CO-loaded methane from a lower location of the methane wash column to the hydrogen stripping column;

(e) conduit means for feeding methane-rich liquid from an intermediate location of the methane wash column to an upper location of the hydrogen stripping column;

(f) conduit means for feeding liquid CO/methane from a lower location of the hydrogen stripping column to the carbon monoxide/methane separation column; and

(g) conduit means for recycling liquid methane from the carbon monoxide/methane separation column to the methane wash column.

**[0011]** The process can also suitably separate gaseous mixtures comprising hydrogen, carbon monoxide and methane, and most suitably will separate a gaseous mixture consisting essentially of these gases.

**[0012]** Preferably a heat exchange means is also provided which is in communication with the methane wash column. The gaseous mixture is then advantageously partially condensed into a gaseous and liquid fraction and at least part of the gaseous fraction fed to the methane wash column for scrubbing. The liquid fraction could be separately fed to another part of the process. However, preferably both the liquid and gaseous fractions are fed to the methane wash column. With this arrangement, a further liquid fraction can be taken off (by further conduit means) at a location below the liquid CO-loaded methane stream and fed directly into the hydrogen stripping column, or combined with the liquid CO-loaded methane stream and then fed into the hydrogen stripping column.

**[0013]** Preferably at least one heat exchanger is associated with the methane wash column to remove the heat of solution, and is located below the location of withdrawal of the methane rich liquid. More preferably more than one heat exchanger is provided and the methane rich liquid is withdrawn from a location above the uppermost heat exchanger.

**[0014]** The methane rich liquid could be withdrawn from any stage of the methane wash column above the bottom stage but preferably from the stage above said (uppermost) heat exchanger. However, it may be withdrawn from a higher stage than said preferred location if lower carbon monoxide losses are desired, since liquid from higher up the column will have a lower carbon monoxide content.

**[0015]** Advantageously the liquid CO/methane stream from step (b) is split into at least two streams, the first is subcooled and the subcooled liquid introduced into a carbon monoxide/methane separation column of step (c), and the second stream is at least partially vaporised and introduced into said separation column at a location below that of said subcooled liquid.

**[0016]** Accordingly in the apparatus the conduit means for feeding liquid CO/methane from the hydrogen stripping column to the carbon monoxide/methane separation column comprises at least two branches debouching into said separation column at vertically spaced locations, and advantageously the branch debouching at the high location includes a heat exchanger for sub-cooling the liquid therein, and the branch debouching into the separation column at the lower location includes a heat exchanger for warming and at least partially vaporising the liquid therein. This arrangement has the advantage over a single conduit inlet in that lower reboiler duty is required for the carbon monoxide/methane separation column.

**[0017]** The invention will now be described by way of example only with reference to the accompanying drawing which is a schematic representation of a preferred embodiment of the process and apparatus of the invention.

**[0018]** With reference to the attached process flow diagram, partially condensed crude synthesis gas (partially condensed such as by a heat exchanger - not shown, into a gaseous and liquid fraction) is fed via conduit 1 to the bottom of methane wash column 2. The vapour rising up through the wash column trays or packing is scrubbed with liquid methane introduced at the top of the column via conduit 3. This dissolves carbon monoxide into the liquid methane and produces an overhead hydrogen product in conduit 4, containing only small quantities of carbon monoxide and methane. The heat of solution of carbon monoxide in the wash liquid is typically removed by indirect heat exchange with at least part of a liquid carbon monoxide heat pump stream in heat exchanger(s) 5. This can be accomplished by at least one contactor heat exchanger as described in US-A-3,813,889 and is shown only schematically here. The

number of contactor heat exchangers, their position and configuration within the methane wash column stages, is such as to most economically provide near isothermal operation of the column.

**[0019]** The loaded liquid carbon monoxide/methane mixture from the bottom stage of the methane wash column, (which typically contains 3% to 4% $H_2$), is removed via conduit 6, reduced in pressure by control valve 7, and introduced into hydrogen stripping column 8, containing trays or packing, where hydrogen is stripped from the liquid in order to achieve the required carbon monoxide product purity specification. Condensed liquid (the liquid fraction) in the crude synthesis gas feed is removed from the sump of the methane wash column via conduit 9, reduced in pressure by control valve 10, and partly vaporised in heat exchanger 11, preferably by indirect heat exchange with at least part of the crude synthesis gas upstream of conduit 1. Alternatively other heat exchange means could be provided. The partly vaporised liquid is then fed to hydrogen stripping column 8 several stages below the introduction of the liquid in conduit 6 to provide part of the stripping vapour for hydrogen removal from the latter stream. A reboiler 12 in the bottom of the hydrogen stripping column provides stripping vapour for the liquid in both feed streams. The liquid introduced via conduit 6 also serves to scrub some of the carbon monoxide from the vapour passing through the hydrogen stripping column. A methane rich scrubbing liquid is withdrawn from an appropriate stage of the methane wash column via conduit 13, reduced in pressure by control valve 14, and used to provide wash liquid to the top of the hydrogen stripping column 8 to further reduce carbon monoxide losses in the reject hydrogen stream from conduit 15.

**[0020]** Liquid from the bottom of the hydrogen stripping column 8 is divided in two branch streams. The first stream is subcooled in heat exchanger 16, reduced in pressure by control valve 17, and introduced to the carbon monoxide/methane separation column 18. The second stream is reduced in pressure by control valve 19, partially vaporised in heat exchanger 20, and also introduced to the carbon monoxide/methane separation column 18 several stages below the subcooled liquid from heat exchanger 16. The two feeds are separated in the carbon monoxide/methane separation column 18 into carbon monoxide and methane streams in conduits 21 and 22 respectively. The column is reboiled by reboiler 23, and reflux is provided by direct introduction of liquid carbon monoxide via control valve 24 and conduit 25. Heat transfer in heat exchangers 16 and 20 is accomplished by indirect heat exchange with other process streams and is not detailed here.

**[0021]** Purified methane liquid in conduit 22 is subcooled in subcooler 26 by indirect heat exchange with other process streams, not detailed here, and then divided. The major part of stream 22 is pumped by pump 27 to methane wash column pressure, further subcooled in heat exchanger 28, and introduced to the top of the methane wash column 2 via conduit 3. The minor portion of stream 22 is removed from the distillation system via control valve 29. Table 1 summarises a mass balance for a typical application of this invention.

TABLE 1

| Stream | | 1 | 3 | 4 | 6 | 9 | 13 | 15 | 21 | 22 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pressure | bar abs | 21.6 | 22.4 | 20.9 | 21.3 | 21.6 | 21.2 | 11.0 | 2.76 | 2.91 | 3.03 |
| Temperature | deg C | -169.5 | -178.8 | -176.5 | -165.7 | -169.5 | -175.7 | -171.1 | -181.6 | -147.5 | -180.8 |
| Flowrate | kgm/h | 947.5 | 338.2 | 549.6 | 515.8 | 141.0 | 79.4 | 22.0 | 441.7 | 374.1 | 101.7 |
| Hydrogen | mol % | 58.91 | | 97.91 | 2.65 | 3.49 | 1.81 | 86.68 | 0.28 | | 0.28 |
| Nitrogen | mol % | 0.14 | | 0.03 | 0.16 | 0.20 | 0.13 | 0.24 | 0.34 | | 0.34 |
| Carbon monoxide | mol % | 36.04 | 0.41 | 0.30 | 45.46 | 71.19 | 8.07 | 8.75 | 99.35 | 0.41 | 99.35 |
| Methane | mol % | 4.90 | 99.58 | 1.76 | 51.72 | 25.11 | 89.99 | 4.32 | 0.03 | 99.58 | 0.03 |
| Vapour fraction | | 0.851 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0.105 |

**[0022]** The above describes a preferred embodiment of the invention, an essential feature being washing the hydrogen stripper column vapour with methane rich liquid withdrawn from an intermediate stage of the methane wash column, preferably from the stage above the uppermost contactor heat exchanger. However this liquid could be withdrawn from any stage of the methane wash column, above the bottom stage, and suitably may be withdrawn from a higher stage than the preferred location if lower carbon monoxide losses are desired, since liquid from higher up the column will have a lower carbon monoxide content.

**[0023]** Liquid withdrawn from the bottom stage of the methane wash column via conduit 6 is a preferred but not an essential feature, and control valve 7 could be eliminated. For example, the hydrogen stripper column could be simplified by mixing the liquid of conduit 6 with the condensed liquid (the liquid fraction) in the crude synthesis gas feed in the column sump. This may be appropriate on a smaller scale plant where the power saved by using this feature does not justify the additional cost.

**[0024]** Heat exchangers 11, 16, and 20 are preferably present and are generally accepted as being cost effective even for small plants. The scrubbing liquid methane must be cold enough to satisfactorily absorb the carbon monoxide in the methane wash column, and such subcooling is advantageously achieved by at least one heat exchanger and preferably two, such as exchangers 26 and 28, communicating with the recycled methane.

**[0025]** In an alternative embodiment the liquid from the bottom of the hydrogen stripping column 8 may be subcooled in heat exchanger 16, and then divided into two branch streams. The first stream would feed the carbon monoxide/methane separation column 18 and the second stream would be reduced in pressure and partially vaporised in heat exchanger 20, before feeding to the carbon monoxide/methane separation column 18 at a lower location than said first stream.

**[0026]** Optionally, the heat of solution may be removed by indirect heat exchange with at least part of a liquid carbon monoxide heat pump stream in a contractor heat exchanger located at the top of the hydrogen stripping column. This may be a cost effective means of achieving higher carbon monoxide recovery or reducing the quantity of methane rich liquid used for washing.

**[0027]** For cases where the hydrogen specification of the carbon monoxide product is less stringent, or where hydrogen would be removed in a downstream nitrogen/carbon monoxide separation column, the hydrogen stripping column reboiler and bottom section of stages may not be required.

**[0028]** From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention, and without departing from the scope of the invention as defined in the following claims, can make various changes and modifications of the invention to adapt it to various usages and conditions.

## Claims

1. A process for separating hydrogen and carbon monoxide from a gaseous mixture thereof comprising:

   (a) scrubbing the gaseous mixture or a gaseous fraction thereof with a liquid methane wash stream in a methane wash column to provide a gaseous hydrogen product stream and a liquid CO-loaded methane stream;

   (b) separating said CO-loaded methane stream into a gaseous hydrogen-rich stream and a liquid CO/methane stream in a hydrogen stripping column refluxed with a methane-rich liquid;

   (c) separating said CO/methane stream into a gaseous carbon monoxide stream and a liquid methane stream; and

   (d) recycling at least part of the liquid methane stream separated from the carbon monoxide stream in step (c) to provide the wash liquid for step (a);

   characterized in that said methane-rich liquid stream is withdrawn from an intermediate location of the methane wash column above the level of removal of said liquid CO-loaded stream therefrom.

2. A process as claimed in Claim 1, wherein said gaseous mixture consists essentially of carbon monoxide, hydrogen, and methane.

3. A process as claimed in Claim 1 or Claim 2, wherein the gaseous mixture is first partially condensed to provide a liquid and gaseous fraction and at least part of the gaseous fraction thereof fed to and scrubbed in the methane wash column of step (a).

4. A process as claimed in Claim 3, wherein both the liquid and gaseous fraction of the gaseous mixture are fed to the methane wash column.

5. A process as claimed in Claim 4, wherein a further liquid stream is withdrawn from the methane wash column at a location below the location of withdrawal of the liquid CO-loaded methane stream and is fed to the hydrogen stripping column.

6. A process as claimed in any one of the preceding claims, wherein said methane-rich liquid stream contains up to 15% carbon monoxide.

7. The process according to Claim 6, wherein said methane-rich liquid stream contains up to 10% carbon monoxide.

8. A process as claimed in any one of the preceding claims, wherein heat of solution is removed by at least one heat exchanger associated with the methane wash column below the location of withdrawal of the methane-rich liquid.

9. An apparatus for the separation of hydrogen and carbon monoxide from a gaseous mixture thereof by a process as defined in Claim 1, said apparatus comprising:

(a) a methane wash column (2);

(b) a hydrogen stripping column (8);

(c) a carbon monoxide/methane separation column (18);

(d) conduit means (6,7) for feeding liquid CO-loaded methane from a lower location of the methane wash column to the hydrogen stripping column (18);

(e) conduit means (13,14) for feeding methane-rich liquid from an intermediate location of the methane wash column (2) to an upper location of the hydrogen stripping column (8);

(f) conduit means (16,17) for feeding liquid CO/methane from a lower location of the hydrogen stripping column (8) to the carbon monoxide/methane separation column (18) ; and

(g) conduit means (2,26,27,28,3) for recycling liquid methane from the carbon monoxide/methane separation column (18) to the methane wash column (2).

10. An apparatus as claimed in Claim 9, wherein there is further provided heat exchange means upstream and communicable with the methane wash column (2) for partially condensing the gaseous mixture into a liquid and gaseous fraction.

11. An apparatus as claimed in Claim 10, wherein a further conduit means (9,10,11) communicates between the methane wash column (2) at a location below the location of the conduit means (6,7) for withdrawal of the CO-loaded stream and the hydrogen stripping column (8).

12. An apparatus as claimed in any one of Claims 9 to 11, wherein at least one heat exchanger (5) is associated with the methane wash column (2) at a location below the intermediate location of the conduit means (13,14) removing the methane-rich liquid.

**Patentansprüche**

1. Verfahren zur Trennung von Wasserstoff und Kohlenmonoxid aus einer Gasmischung, umfassend:

(a) Gaswäsche des gasförmigen Gemisches oder einer gasförmigen Fraktion davon mit einem flüssigen Methanwaschstrom in einer Methanwaschsäule, um einen gasförmigen Wasserstoffproduktstrom und einen flüssigen CO-beladenen Methanstrom zu erzeugen:
(b) Auftrennen des CO-beladenen Methanstroms in einen gasförmigen wasserstoffreichen Strom und einen flüssigen CO/Methan-Strom in einer Wasserstoffstrippersäule, die mit einer methanreichen Flüssigkeit reflu-

xiert wird;
(c) Auftrennen des CO/Methan-Stroms in einen gasförmigen Kohlenmonoxidstrom und einen flüssigen Methanstrom; und
(d) Rückführung von mindestens einem Teil des flüssigen Methanstroms, der in Schritt (c) von dem Kohlenmonoxidstrom abgetrennt wurde, um die Waschflüssigkeit für Schritt (a) zu liefern;

dadurch gekennzeichnet, dass der methanreiche Flüssigkeitsstrom von einer Zwischenstelle der Methanwaschsäule oberhalb des Entnahme- bzw. Entfernungsniveaus des flüssigen CO-beladenen Stroms abgezogen wird.

2. Verfahren nach Anspruch 1, bei dem das gasförmige Gemisch im Wesentlichen aus Kohlenmonoxid, Wasserstoff und Methan besteht.

3. Verfahren nach Anspruch 1 oder 2, bei dem das gasförmige Gemisch zuerst teilweise kondensiert wird, um eine flüssige und eine gasförmige Fraktion zu erzeugen, und mindestens ein Teil der gasförmigen Fraktion der Methanwaschsäule von Schritt (a) zugeführt und dort gewaschen wird.

4. Verfahren nach Anspruch 3, bei dem sowohl die flüssige als auch die gasförmige Fraktion des gasförmigen Gemisches der Methanwaschsäule zugeführt werden.

5. Verfahren nach Anspruch 4, bei dem ein weiterer Flüssigkeitsstrom von der Methanwaschsäule aus einer Stelle unterhalb der Abzugsbereichsstelle des flüssigen CO-beladenen Methanstroms abgezogen und der Wasserstoffstrippersäule zugeführt wird.

6. Verfahren nach einem der vorstehenden Ansprüche, bei dem der methanreiche Flüssigkeitsstrom bis zu 15 % Kohlenmonoxid enthält.

7. Verfahren nach Anspruch 6, bei dem der methanreiche Flüssigkeitsstrom bis zu 10 % Kohlenmonoxid enthält.

8. Verfahren nach einem der vorstehenden Ansprüche, bei dem Lösungswärme durch mindestens einen Wärmeaustauscher, der der Methanwaschsäule unterhalb der Abzugsstelle der methanreichen Flüssigkeit zugeordnet ist, abgeführt wird.

9. Vorrichtung zur Trennung von Wasserstoff und Kohlenmonoxid aus einer Gasmischung durch ein Verfahren nach Anspruch 1, die Vorrichtung umfassend:

(a) eine Methanwaschsäule (2);
(b) eine Wasserstoffstrippersäule (8);
(c) eine Kohlenmonoxid/Methan-Trennsäule (18);
(d) eine Leitungsanordnung (6, 7) für die Zuführung des flüssigen, CO-beladen Methans aus einer unteren Stelle der Methanwaschsäule in die Wasserstoffstrippersäule (18);
(e) eine Leitungsanordnung (13, 14) für die Zuführung der methanreichen Flüssigkeit von einer Zwischenstelle der Methanwaschsäule (2) zu einer oberen Stelle der Wasserstoffstrippersäule (8);
(f) eine Leitungsanordnung (16, 17) für die Zuführung von flüssigem CO/Methan von einer unteren Stelle der Wasserstoffstrippersäule (8) in die Kohlenmonoxid/Methan-Trennsäule (18); und
(g) eine Leitungsanordnung (2, 26, 27, 28, 3) für die Rückführung des flüssigen Methans von der Kohlenmonoxid/Methan-Trennsäule (18) in die Methanwaschsäule (2).

10. Vorrichtung nach Anspruch 9, die außerdem stromaufwärts zu und in Verbindung bringbar mit der Methanwaschsäule (2) einer Wärmeaustauschvorrichtung für die teilweise Kondensation des gasförmigen Gemisches in eine flüssige und eine gasförmige Fraktion versehen ist.

11. Vorrichtung nach Anspruch 10, in der eine weitere Leitungsanordnung (9, 10, 11) zwischen der Methanwaschsäule (2) an einer Stelle unterhalb der Stelle der Leitungsanordnung (6, 7) zum Abziehen des CO-beladenen Stroms und der Wasserstoffstrippersäule (8) kommuniziert.

12. Vorrichtung nach einem der Ansprüche 9 bis 11, bei der mindestens ein Wärmeaustauscher (5) der Methanwaschsäule (2) an einer Stelle unterhalb der Zwischenstelle der Leitungsanordnung (13, 14) für die Entfernung der methanreichen Flüssigkeit zugeordnet ist.

**Revendications**

1. Procédé pour séparer l'hydrogène et l'oxyde de carbone dans un mélange gazeux contenant ceux-ci, comprenant les opérations consistant à :

   (a) laver le mélange gazeux ou une fraction gazeuse de celui-ci par un flux de méthane liquide dans une colonne de lavage par du méthane, pour fournir un flux d'hydrogène gazeux et un flux de méthane liquide chargé de CO ;

   (b) séparer ledit flux de méthane chargé de CO en un flux gazeux riche en hydrogène et en un flux de CO / méthane liquide dans une colonne de stripping de l'hydrogène dans laquelle on produit un reflux de liquide riche en méthane ;

   (c) séparer ledit flux de CO / méthane en un flux d'oxyde de carbone gazeux et en un flux de méthane liquide ; et

   (d) recycler au moins une partie du flux de méthane liquide séparé du flux d'oxyde de carbone à l'étape (c) pour fournir le liquide de lavage utilisé à l'étape (a) ;

   caractérisé en ce que ledit flux de liquide riche en méthane est soutiré en un emplacement intermédiaire de la colonne de lavage par le méthane au-dessus du niveau de soutirage dudit flux de liquide chargé de CO de ladite colonne.

2. Procédé selon la revendication 1, dans lequel ledit mélange gazeux est constitué essentiellement d'oxyde de carbone, d'hydrogène et de méthane.

3. Procédé selon la revendication 1 ou la revendication 2, dans lequel le mélange gazeux est d'abord condensé partiellement pour fournir une fraction liquide et une fraction gazeuse et dans lequel au moins une partie de la fraction gazeuse est dirigée vers la colonne de lavage par le méthane de l'étape (a) pour y subir un lavage.

4. Procédé selon la revendication 3, dans lequel aussi bien la fraction liquide que la fraction gazeuse du mélange gazeux sont dirigées sur la colonne de lavage par le méthane.

5. Procédé selon la revendication 4, dans lequel un flux additionnel de liquide est soutiré de la colonne de lavage par le méthane en un emplacement en dessous de l'emplacement de soutirage du flux de méthane liquide chargé de CO, pour être dirigé sur la colonne de stripping de l'hydrogène.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel ledit flux liquide riche en méthane contient jusqu'à 15 % d'oxyde de carbone.

7. Procédé selon la revendication 6, dans lequel ledit flux liquide riche en méthane contient jusqu'à 10 % d'oxyde de carbone.

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel la chaleur de dissolution est évacuée par au moins un échangeur thermique en communication avec la colonne de lavage par le méthane en dessous de l'emplacement de soutirage du liquide riche en méthane.

9. Appareil pour séparer l'hydrogène et l'oxyde de carbone dans un mélange gazeux contenant ceux-ci par un procédé comme défini dans la revendication 1, ledit appareil comprenant :

   (a) une colonne de lavage (2) par du méthane ;

   (b) une colonne de stripping (8) de l'hydrogène ;

   (c) une colonne de séparation (18) de l'oxyde de carbone et du méthane ;

   (d) des moyens de conduites (6, 7) pour amener le méthane liquide chargé de CO depuis un emplacement dans le bas de la colonne de lavage par le méthane vers la colonne de stripping (18) de l'hydrogène ;

(e) des moyens de conduites (13, 14) pour amener le liquide riche en méthane depuis un emplacement intermédiaire de la colonne de lavage (2) par le méthane vers un emplacement dans le haut de la colonne de stripping (18) de l'hydrogène ;

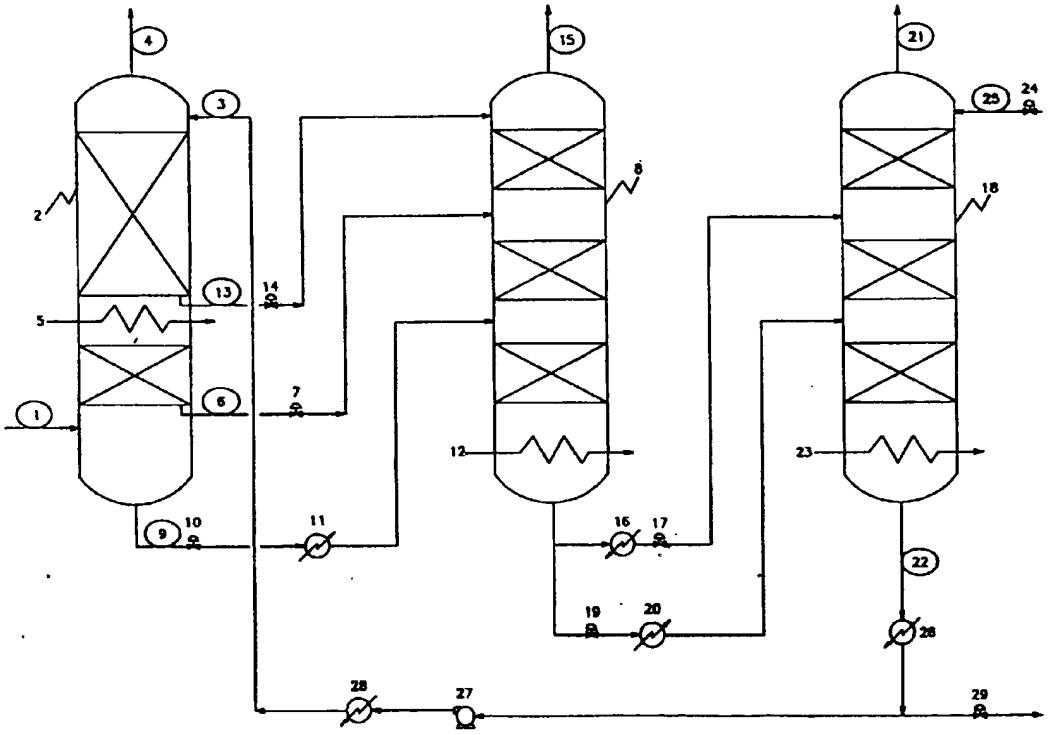
(f) des moyens de conduites (16, 17) pour amener le mélange CO / méthane liquide depuis un emplacement dans le bas de la colonne de stripping (8) de l'hydrogène vers la colonne de séparation (18) de l'oxyde de carbone et du méthane ; et

(g) des moyens de conduites (2, 26, 27, 28, 3) pour recycler le méthane liquide de la colonne de séparation (18) de l'oxyde de carbone et du méthane vers la colonne de lavage (2) par le méthane.

**10.** Appareil selon la revendication 9, dans lequel on prévoit, en outre, un moyen d'échange thermique en amont de la colonne de lavage (2) par le méthane et en communication avec celle-ci, pour condenser partiellement le mélange gazeux , afin de fournir une fraction liquide et une fraction gazeuse.

**11.** Appareil selon la revendication 10, dans lequel d'autres moyens de conduites (9, 10, 11) assurent la communication entre la colonne de lavage (2) par le méthane en un emplacement en dessous de l'emplacement des moyens de conduites (6, 7) pour soutirer le flux chargé en CO, et la colonne de stripping (8) de l'hydrogène.

**12.** Appareil selon une quelconque des revendications 9 à 11, dans lequel au moins un échangeur thermique (5) est en communication avec la colonne de lavage (2) par le méthane en un emplacement en dessous de l'emplacement intermédiaire des moyens de conduites (13, 14) pour évacuer le liquide riche en méthane.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